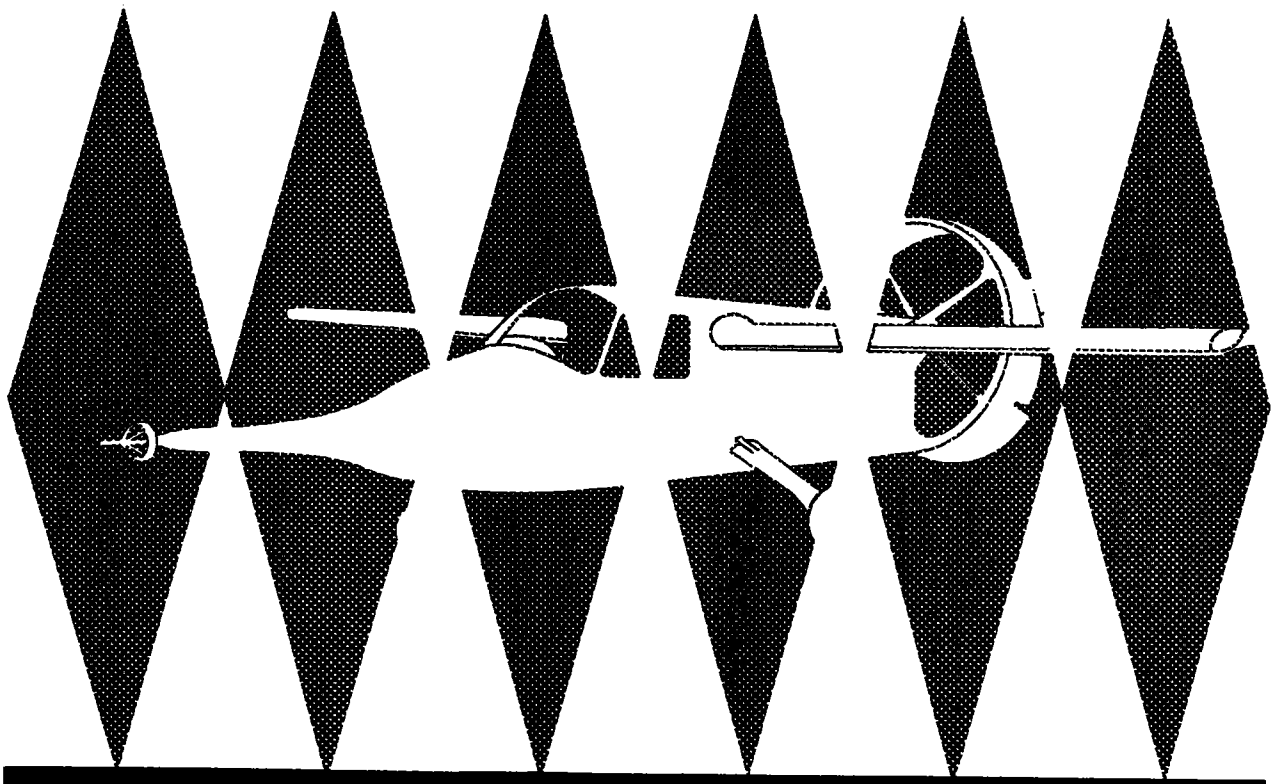


THE ARMY AVIATION STORY

PART V - V/STOL AIRCRAFT

BY MSGT THOMAS M. LANG

WHAT WILL BE the nature of future Army aircraft? When work began on the Tower of Babel, and ever since, engineers have been known as grandiose thinkers. The ancient aeronautical engineer who invented the flying carpet demonstrated a high degree of imagination. His spiritual descendants are carrying on in the same tradition. Today, newly discovered principles of aerodynamics are constantly being explored and many will be adapted in future Army aircraft.

In size alone, Army aircraft of the future may reach fantastic extremes, both large and small. Scientists continue to devise miniature machines having the same capabilities as their large predecessors. On the other hand, there is a demand for aircraft capable of carrying increasingly large loads.

In October 1959 the Army Aircraft Development Plan was initiated. This plan provided guidance for the future of Army Aviation and included Army Study Requirements (ASRs). These ASRs described broad objectives to be incorporated in the development of aircraft for light observation, tactical transportation, and manned surveillance.

These ASRs were released to industry at Fort Monroe, Va., on 1 December 1959. In February 1960 the aviation industry submitted 119 design concepts as possible answers to the Army's future aviation requirements.

After thoroughly analyzing the Army study requirements and industry's design concepts, the aircraft developments program was started.

As a first step it was decided to obtain a new light observation helicopter (LOH) which should be phased into the system during the 1965-1970 time frame. Specifications called for this aircraft to be a turbine powered, easily maintained, lightweight, single-rotor helicopter. It was intended that this aircraft should be used primarily for visual observation and target acquisition, command control, and reconnaissance.

Twelve companies submitted LOH bids, and three — Bell Helicopter Company, Hiller Aircraft Corporation, and Hughes Tool Company, Aircraft Division — won the preliminary competition. Each has contracted to produce five prototype models, from which a final winner will be selected. It is anticipated that the LOH will eventually phase out the L-19, H-13, and H-23 aircraft currently carried on the Army Aviation inventory.

Another aircraft being developed for Army consideration is Bell's XV-3, which combines the characteristics of the helicopter and the airplane. This fixed wing aircraft has prop-rotors capable of being tilted up for helicopter-type vertical takeoffs and landings, and tilted forward while airborne for airplane-type flight.

The original XV-3 project was started in 1951 under a joint Army-Air Force contract which called for Bell Helicopter Company, Doak Aircraft Company, Inc., and Ryan Aeronautical Company to develop a convertiplane for Army use. Bell began extensive testing and later the other two companies dropped out of the program. Bell built two XV-3s (4147 and 4148). The first made its initial flight on 23 August 1955. On 25 October 1956 the first XV-3 (No. 4147) was destroyed in an accident caused by instability of the three-bladed prop-rotor as then developed. The prop-rotors were replaced on the second XV-3 (No. 4148) with the two-bladed semi-rigid model, which proved satisfactory.

The second XV-3 was the first aircraft of its kind to achieve 100 percent inflight conversion of its tilting prop-rotors. Bell test pilot Bill Quinlan made the historic flight on 18 December 1958 at Bell's Fort Worth, Texas, plant. The XV-3 conversion takes about 10 seconds if done continuously or it may be accomplished on a gradual step-by-step basis. This process entails transferring the lift from the rotors to the wings without abrupt loss of altitude.

Maj E. E. Kluever, the first Army pilot to fly the Bell XV-3 convertiplane, stands beside it after completing the flight on 8 August 1961 at the National Aeronautics and Space Administration's Ames Research Center, Moffett Field Calif. The flight included hovering, low speed maneuvers, and conversions

Photo by NASA

The convertiplane combines the VTOL characteristics of the helicopter with the high speed and greater range of the fixed wing aircraft. In the event of an inflight power failure while in an airplane configuration the prop-rotors can be tilted to a helicopter - type configuration and the aircraft autorotated to the ground.

A research aircraft in which the Army and Navy have interests is the Mississippi State MARVEL (Mississippi Aerophysics Research Vehicle with Extended Latitude).

This project is unusual in that it is not immediately concerned with the development of a finished product aircraft. Actually the MARVEL is to be the last in a series of research or test bed aircraft used to explore and marry the following aerodynamic and structural innovations.

- *Boundary layer control (BLC).* Thousands of tiny pinholes are drilled along the surface of the wings of an aircraft. The aircraft's engine drives a pump to provide a suction through these holes which makes the passing airflow adhere to the airfoil. The MARVEL project is investigating both laminar boundary layer control and high lift boundary layer control—both of which will be discussed below.

- *Use of glass fiber.* While glass fiber is heavier than some materials used on aircraft, it can be produced with a very smooth finish — a prerequisite to laminar boundary layer control.

- *Camber - changing wing.* The shape of the entire airfoil can be changed from within the

cockpit to provide maximum lift/minimum airspeed or maximum airspeed/minimum lift.

- *Ducted propeller.* Experimental work at Mississippi State has shown that the shrouded prop can double the thrust of the open pusher propeller.
- *Control System.* Rudders and elevators attached to the shroud are expected to provide satisfactory directional control.

In 1950 Mississippi State researchers were using the Schweizer TG-3A sailplane to explore the characteristics and potential of laminar flow boundary layer control. The intent was to reduce drag and thereby improve cruising characteristics and extend the range of an aircraft.

At the same time the researchers were interested in further exploring and developing the potential of high lift boundary layer control. Research continued on laminar and high lift BLC with the TG-3A. However, by 1955 high lift BLC research was being done with the L-21 and L-19, while laminar BLC work with the TG-3A continued as a separate but related program.

While experimenting with high lift boundary layer control, it soon became apparent that high thrust greatly improved the aircraft's performance during steep climbs and while operating from short fields. Consequently, Mississippi State's researchers turned to the Anderson-Greenwood AG-14, which was modified to make use of a shrouded pusher propeller aft of the fuselage. Thus, Mississippi State researchers were exploring the BLC potential on three fronts—laminar flow, high lift, and high thrust.

It was at this point in 1955 that the MARVEL concept was born. Mississippi State researchers decided to consolidate their three-pronged attack on BLC problems by incorporating the structural and aerodynamic innovations mentioned above into one research aircraft—the MARVEL.

Mississippi State's Marvelette

To date the MARVEL has not been completed. However, its prototype the XAZ-1 Marvelette was first flown in March 1962. The Marvelette has an all-metal fuselage, but has glass fiber, camber-changing wings which are being tested for incorporation into the MARVEL.

The MARVEL will be constructed almost entirely of glass fiber. Like the Marvelette, it will incorporate a ducted pusher propeller and boundary layer control — both for high lift and laminar flow. However, the MARVEL is expected to have a slightly different appearance from its prototype and may have minor modifications, depending on the results of Marvelette research. The MARVEL is expected to be ready for flight in late 1963 or early 1964.

If the Mississippi State MARVEL presents an unusual appearance, then surely the giant XC-142 tilt-wing is "out of this world." Now in the advanced planning stage, this tri-service project started on 1 February 61 with the initiation of a design competition.

Design proposals were received from ten companies on 3 April 1961. Most of the designs incorporated either ducted propellers or tilt-wings. One included two short tandem wings with ducted propellers at each wingtip.

In September 1961 the design winner—a tilt-wing model—was announced. Three companies are participating in the project and it is expected that engineering flight as well as operational evaluation testing of the completed aircraft will take place in FY 1965.

Chance Vought, subsidiary of Ling-Temco-Vought is the prime contractor. Ryan Aeronautical Company is building the aft section of the plane, including the tail, engine mounts, and nacelles. Hiller Aircraft Corporation is designing and building the gearing shafts, propellers, flaps, and ailerons.

As now envisioned the XC-142 will be capable of transporting four tons of supplies and equipment. Cruising speed is forecast at 250-300 knots. With a full payload, or 32 fully equipped troops, the XC-142 is expected to have a combat radius of 200 to 300 nautical miles. Without cargo and equipped with extra fuel tanks this aircraft is expected to have a ferry range of approximately 2,600 nautical miles.

That odd-looking kite you may see someday above the battlefield will not be flown by a little boy with a ball of twine, nor need the time of the year necessarily be March.

What you see probably will

be the Flex Wing aircraft as conceived by Mr. Francis M. Rogallo of National Aeronautics and Space Administration. Now being developed by the U. S. Army and Ryan Aeronautical Company, the Flex Wing embodies principles developed by such aviation pioneers as Otto Lilienthal and uses a pusher-type propeller, as did the Wright Brothers' aircraft.

Basically this aircraft is a flexible wing fastened to a rigid frame which supports a platform carrying the pilot, engine and payload.

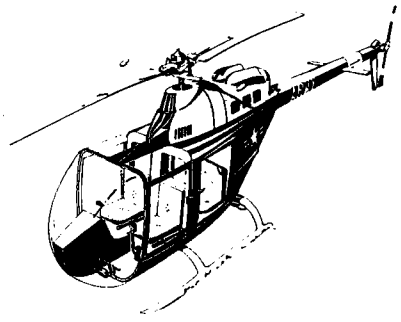
When used as a towed glider behind a helicopter it has been estimated that the Flex Wing could carry six times the payload of the helicopter.

A small version of the Flex Wing may be used as a remotely controlled drone. An enormous version, without engine, might be folded and attached to a rocket booster. After the rocket is fired and the booster dropped, the Flex Wing would unfold and glide to the ground.

In counterinsurgency operations, it may be feasible to glide the Flex Wing silently to a prearranged spot, unload supplies and pick up wounded for medical evacuation. This silent feature would be a big advantage in that it would enable all activity in the area to be completed before starting the sound of the engine for departure.

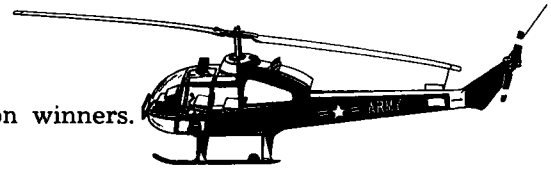
Also, the Flex Wing may be substituted for the parachute when dropping Special Forces personnel. The advantage over the parachute would be a softer landing and pinpoint accuracy. It is predicted that a soldier jumping at an altitude of 5,000 feet could select any landing site up to approximately 4 miles away. In this model, collapsible rubber tubes would replace the rigid frame of the wing to allow for compact folding and storage aboard an aircraft. The tubes would be inflated by means of a cartridge.

Neither current nor projected future Army Aviation aircraft resemble in appearance or capability that first Wright biplane delivered to Fort Myer, Va., on 20 August 1908 for user testing. As would be expected, many changes have evolved over the years. But as matters now stand Army Aviation, though very much in the air, still rests on solid ground in assurance of future growth.

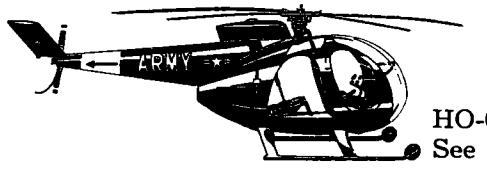


HO-4—Bell D-250, four-place light observation helicopter.

One of the three winners of the Army's design competition for a light observation helicopter. The HO-4, like its competitors in the finals of the LOH program, is being designed as a lightweight, single rotor, four-place helicopter capable of carrying a 400-pound payload (in addition to the pilot and fuel). Each aircraft will use an Allison T-63 gas turbine engine. Plans call for each winner to deliver the Army one LOH a month for five months beginning in October 1963.



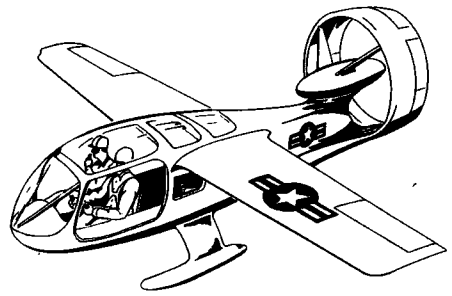
HO-5—Hiller 1100. One of the LOH design competition winners. See HO-4 for characteristics.

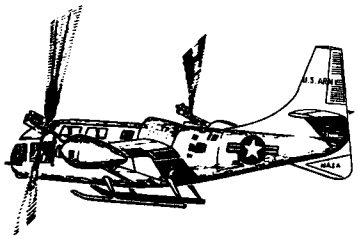


HO-6—Hughes 369. One of the LOH design competition winners. See HO-4 for characteristics.

MARVEL—Mississippi State, two-place, research aircraft.

The Army is assisting Mississippi State University in development of the MARVEL as a test bed aircraft to explore various aerodynamic and structural concepts (see accompanying story). It is hoped that the MARVEL will have a level-flight speed of 240 mph and a landing speed of 40 mph. It will be powered by a 263 hp Allison turboprop T-63 engine, also being developed by the manufacturer for Army consideration. First flight is set for 1963-4.

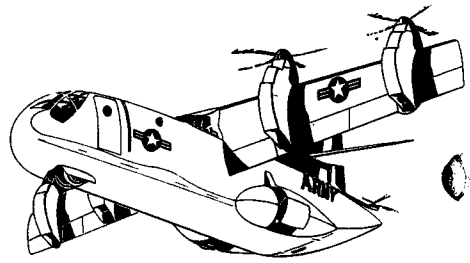


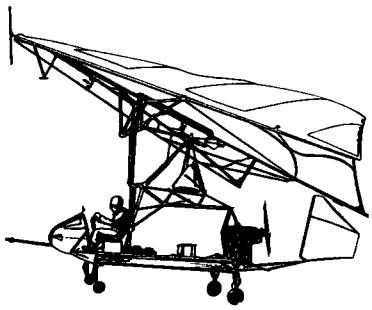


XV-3 (H-33)—Bell, four-place convertiplane.

Two XV-3 aircraft were built in FY 1955 as a part of an Army research program of V/STOL aircraft. The XV-3 uses a 450 hp Pratt & Whitney engine (R-985-AN-3). The XV-3 project is still being developed.

XC-142—Ling-Temco-Vought, Ryan, Hiller; pilot, copilot and 32 troops; VTOL transport. This is an Army-Navy-Air Force project. Plans call for five aircraft to be built. Each will use four General Electric T-64-GE-6 turboshaft engines.



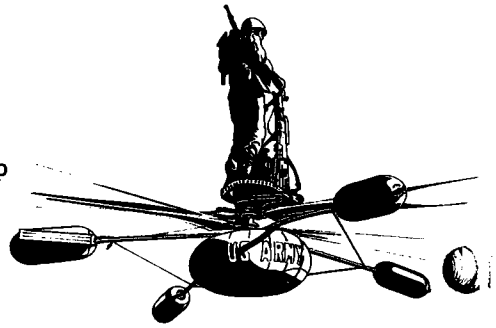


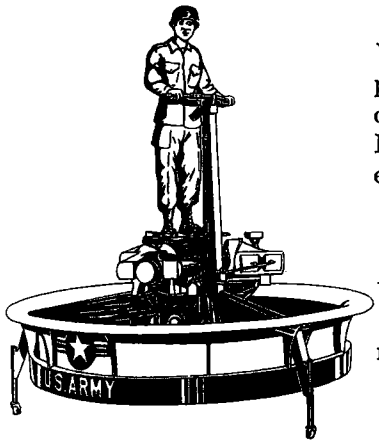
Flex Wing—Ryan, towed glider or drone.

The first prototype model of this aircraft was powered by a 100 hp Continental engine but later a 180 hp Lycoming engine was substituted. Future experiments may show that turbine or rocket engines could be used, with horsepower appropriate to the size and mission. Small, powered models may become drones and large models without engines used as towed gliders. Personnel and cargo capacity will vary according to model.

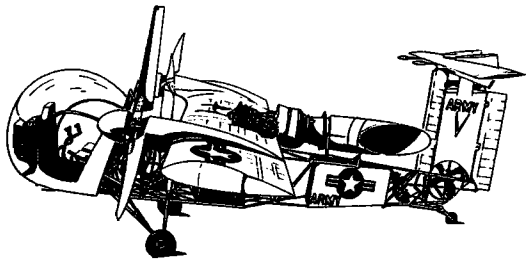
HZ-1—De Lackner, one-place, flying platform.

The Army obtained the HZ-1 for evaluation. It used a 40 hp Kiekhaefer Mercury Mark 55 engine.





VZ-1 *Pawnee* — Hiller, one-place, flying platform. The Army obtained the VZ-1 for evaluation. It used three 40 hp Barmotive engines.

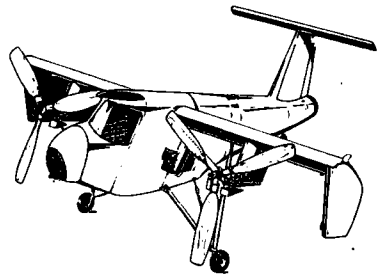


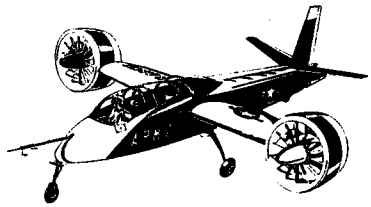
VZ-2 (upper right)—Vertol, two-place, tilt wing.

The VZ-2 is being developed for Army consideration. It is commercially designated Model 76 and uses a 600 hp Lycoming engine (T-53-L-1A).

VZ-3 *Vertiplane*—Ryan, one-place, deflected slipstream.

The VZ-3 is being developed for Army consideration. It is commercially designated Model 92. It uses an 825 hp Lycoming engine (T-53-L-1). The VZ-3 has been flown as slow as 15 knots in level flight and descended at 1600 fpm at idle power settings.



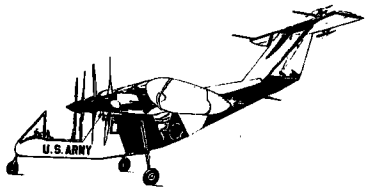


VZ-4—Doak, two-place, convertiplane.

This is an Army project to develop a V/STOL aircraft. The VZ-4 is commercially designated Model 16. Two wing-tip ducted fans are powered by an 825 hp Lycoming engine (T-53-L-1).

VZ-5—Fairchild, one-place, deflected slipstream.

This is another Army project to develop a V/STOL aircraft. The VZ-5 is commercially designated M-224-1, and uses an 1100 hp General Electric engine (T-58-2A). The aircraft was built to evaluate the deflected slipstream principle and control problems involved in transition from hovering to forward flight. It is not intended for future production.



VZ-6—Chrysler, one-place aerial jeep.

The VZ-6 was developed for Army consideration. It was a ground effects machine powered by two 380 hp reciprocating engines. The project was terminated following a crash of the VZ-6 in 1959.

No drawings available on VZ-6 through VZ-9.

VZ-7 — Curtiss-Wright, two-place, aerial jeep.

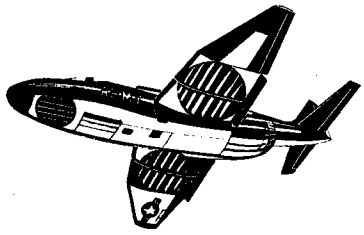
The VZ-7, another Army project, was a ground effects machine using a 425 hp Aertouste II turbine engine. The project has been terminated.

VZ-8 — Piasecki, four-place, aerial jeep.

The VZ-8 is being developed for Army consideration. It is commercially designated Model 59-K. It is a ground effects machine which originally used two 180 hp Lycoming engines (0-360-A2A). It was later redesigned with a 425 hp Turbomeca Aertouste II B engine.

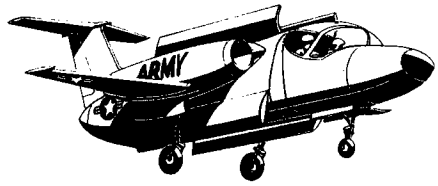
VZ-9—Avro Aircraft Limited, "flying saucer."

This was an Army-Air Force project to develop a "flying saucer" shaped ground effects machine. It was powered by three Continental J-69 turbojet engines.



VZ-10 *Hummingbird* (redesignated XV-4A)—Lockheed-Georgia, two-place, jet thrust diverter.

Two of these experimental aircraft are being built for Army evaluation. An augmented jet thrust diverter system is incorporated in the design. It is believed that this feature will enable the aircraft to dart from ground hover to a speed of approximately 500 mph (Mach .68) at 35,000 feet altitude in approximately 3 minutes. The VZ-10 uses two Pratt & Whitney JT 12A-3 turbojets. It made its first conventional flight in the summer 1962.



VZ-11—Ryan two-place, lift-fan propulsion.

This aircraft will be powered by two General Electric J-85 jet engines and will utilize the lift-fan propulsion system. It is expected to make its first flight in mid-summer 1963. Available data indicates that it will be capable of taking off vertically and then assuming forward speed in excess of 500 mph.

Off-the-shelf aircraft considered, but not in general use by the Army

Pioneer—Scottish Aviation Limited, five-place fixed wing aircraft. It uses a nine-cylinder, single bank 500 hp radial engine.

Twin Pioneer—Scottish Aviation Limited, pilot, radio operator and 16 passengers; twin-engine aircraft. Uses Alvis Leonides 520/540 hp radial engines.

OE-2—Cessna, two-place, fixed-wing aircraft. It uses a 265 hp Continental, six-cylinder, horizontally opposed, supercharged, air-cooled engine.

HOK-1—Kaman, pilot, copilot and three passenger helicopter. This aircraft uses twin, two-bladed, intermeshing, counter-rotating rotors, and has a 600 hp Pratt &. Whitney engine (R-1340-28).

G-91—Fiat, one-place, NATO jet airplane. It uses a Bristol-Siddeley Orpheus MK 803 axial flow turbojet engine which has a rated sea level static thrust of 5,000 pounds.

G-91T—trainer version of G-91; two-place, tandem.

N-156—Northrop, one-place supersonic airplane. It uses two YJ-85-GE-5 axial flow turbojet engines which develop 2,500 pounds of static thrust each at military power and 3,850 pounds with afterburner.

T-38—trainer version of N-156; two-place, tandem.

A4D—Douglas, one-place, jet airplane. It uses a Wright J65-W-16A turbojet engine with a multistage, axial flow compressor driven by a two-stage turbine which develops 7,700 pounds of static thrust at military power.